

Appendix C

Hydrologic Record Missing Values

Five missing values (-901) were found in the updated hydrologic record supplied by the Los Angeles District. The following values were inserted into the record based on the values surrounding the missing data.

Date	Value in Record	Changed to
July 1, 1981	-901	0.0
July 2, 1981	-901	0.0
August 30, 1983	-901	5.0
August 31, 1983	-901	5.0
August 31, 1984	-901	28.0

Appendix D

Release Rules

Optimization Based Alternative (OBA) 2A

A simulation rule based on HEC-PRM results for all interests weighted equally. The rule was designed to set releases to maintain a target storage level. The release decision is based on a deviation from the target storage and the inflow. The rule can be written as:

Storage Condition	Criteria	Release (Subject to Release Capacity)
If Storage Deviation	≥ 0	Maximum of: Good Release, $0.95 * \text{Net Inflow}$, or $0.90 * \text{Storage Deviation}$
ElseIf Storage Deviation	≥ -500	Maximum of: Good Release, or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$
ElseIf Storage Deviation	$> \text{Dry Deviation}$	Maximum of: Mid Release, or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$
Else		Maximum of: Low Release, or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$

Where:

Storage Deviation = Current Storage - Target Storage

Net Inflow = Inflow - Evaporation

Month	Target Storage (KAF)	Dry Deviation (KAF)	Good Release (cfs)	Mid Release (cfs)	Low Release (cfs)
Jan	158.1	-9.1	25	10	10
Feb	159.4	-7.0	40	25	10
Mar	160.3	-0.4	40	25	10
Apr	159.4	-1.7	40	25	10
May	156.7	-2.2	40	25	10
Jun	156.1	-2.5	50	25	10
Jul	157.0	-3.8	50	25	10
Aug	156.1	-5.4	50	25	10
Sep	155.2	-5.3	50	25	10
Oct	155.2	-6.5	40	15	10
Nov	154.5	-7.5	25	10	10
Dec	156.7	-12.7	25	10	10

Optimization Based Alternative (OBA) 3A

OBA 2A modified to relax emphasis on maintaining target storage. (Changes from OBA 2A are underlined.) The rule can be written as:

Storage Condition	Criteria	Release (Subject to Release Capacity)
If Storage Deviation	≥ 0	Maximum of: Good Release, $0.95 * \text{Net Inflow}$, or $0.90 * \text{Storage Deviation}$
ElseIf Storage Deviation	$\geq \underline{-1,500}$	Maximum of: Good Release, <u>$0.85 * \text{Net Inflow}$</u> , or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$
ElseIf Storage Deviation	$> \text{Dry Deviation}$	Maximum of: Mid Release, <u>$0.50 * \text{Net Inflow}$</u> , or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$
Else		Maximum of: Low Release, or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$

Where:

Storage Deviation = Current Storage - Target Storage

Net Inflow = Inflow - Evaporation

Dry Deviation = -31,000

Month	Target Storage (KAF)	Good Release (cfs)	Mid Release (cfs)	Low Release (cfs)
Jan	158.1	25	10	10
Feb	159.4	40	25	10
Mar	160.3	40	25	10
Apr	159.4	40	25	10
May	156.7	40	25	10
Jun	156.1	50	25	10
Jul	157.0	50	25	10
Aug	156.1	50	25	10
Sep	155.2	50	25	10
Oct	155.2	40	15	10
Nov	154.5	25	10	10
Dec	156.7	25	10	10

Optimization Based Alternative (OBA) 3C

OBA 3A modified to relax emphasis on maintaining target storage. (Changes from OBA 3A are underlined.) The rule can be written as:

Storage Condition	Criteria	Release (Subject to Release Capacity)
If Storage Deviation	≥ 0	Maximum of: Good Release, <u>0.50</u> * Net Inflow, or <u>0.10</u> * Storage Deviation
ElseIf Storage Deviation	\geq <u>-40,000</u>	Maximum of: Good Release, <u>0.50</u> * Net Inflow, or <u>0.10</u> * (Net Inflow + Storage Deviation)
ElseIf Storage Deviation	$>$ Dry Deviation	Maximum of: Mid Release, 0.50 * Net Inflow, or <u>0.10</u> * (Net Inflow + Storage Deviation)
Else		Maximum of: Low Release, or <u>0.10</u> * (Net Inflow + Storage Deviation)

Where:

Storage Deviation = Current Storage - Target Storage

Net Inflow = Inflow - Evaporation

Dry Deviation = -50,000

Month	Target Storage (KAF)	Good Release (cfs)	Mid Release (cfs)	Low Release (cfs)
Jan	158.1	25	10	10
Feb	159.4	40	25	10
Mar	160.3	40	25	10
Apr	159.4	40	25	10
May	156.7	40	25	10
Jun	156.1	50	25	10
Jul	157.0	50	25	10
Aug	156.1	50	25	10
Sep	155.2	50	25	10
Oct	155.2	40	15	10
Nov	154.5	25	10	10
Dec	156.7	25	10	10

Optimization Based Alternative (OBA) 3G

A simplified form of OBA 3A modified to relax emphasis on maintaining target storage. (Changes from OBA 3A are underlined.) An additional component was added so that if a release greater than or equal to 1,000 cfs was made in January through May, the release would be kept at or above 1,000 cfs for at least seven consecutive days. This new component is referred to as a “Pulse Flow Extender” (PFE). The rule can be written as:

Storage Condition	Criteria	Release (Subject to Release Capacity)
If Storage Deviation	≥ 0	Maximum of: Good Release, $0.95 * \text{Net Inflow}$, or $0.90 * (\text{Net Inflow} + \text{Storage Deviation})$
ElseIf Storage Deviation	$\geq \underline{-80,566}$	Maximum of: Good Release, or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$
Else		Maximum of: Low Release, or $0.95 * (\text{Net Inflow} + \text{Storage Deviation})$

Where:

Storage Deviation = Current Storage - Target Storage

Net Inflow = Inflow - Evaporation

Target Storage = 160,977

Month	Good Release (cfs)	Mid Release (cfs)	Low Release (cfs)
Jan	25	10	10
Feb	40	25	10
Mar	40	25	10
Apr	40	25	10
May	40	25	10
Jun	50	25	10
Jul	50	25	10
Aug	50	25	10
Sep	50	25	10
Oct	40	15	10
Nov	25	10	10
Dec	25	10	10

Pulse Flows are sustained by:

IF Release > 1,000 cfs THEN

IF Month > 0 and < 6

Maintain Release >= 1,000 cfs for at least 7 days

ENDIF

ENDIF

Appendix E

Draw-Down Release Rules

Low Level Draw-Down Release Rule

The target storage for September and October are set to provide enough water for base flows. If the storage is higher than the target storage for that month, releases are made to try and meet the target storage by the end of the month. No releases are made from November 1 to November 14.

Storage Condition	Criteria	Release (Subject to Release Capacity)
If Storage	> Target Storage	Maximum of: Good Release, or Storage Deviation * (Current Day / 31)
ElseIf Storage	>= 80,411 (1,100 ft)	Good Release
Else		Low Release

Where:

Storage Deviation = Current Storage - Target Storage

Month	Target Storage (acre-feet)	Good Release (cfs)	Low Release (cfs)
Sep	83,911 (1,101.2 ft)	50	10
Oct	80,411 (1,100 ft)	40	10
Nov 1 - 14	80,411	0	0

Forced Draw-Down Release Rule

This release rule is implemented eight years have passed since the last outlet tunnel inspection. The rule is implemented in the Spring to try and release any surplus water as a spring flushing flow with an extended recession as outlined in the *Proposed Water Management Plan For Alamo Lake and the Bill Williams River*, (BWRCTC, 1994). Determining the amount of surplus water is based on a target elevation of 1106 feet at the end of April to provide about 17,800 acre-feet of water make base flow releases until November.

The rule is implemented as follows:

- Determine amount of surplus on April 1.
Surplus = Storage - 109, 611
- If Surplus > 0 then set a pulse flow strategy.

Condition	Criteria	Pulse Flow Characteristics
If Surplus	> 75,000 ac-ft	Peak Flow = 7,000 cfs; Recession Length = 20 days
ElseIf Surplus	> 50,000 ac-ft	Peak Flow = 5,000 cfs; Recession Length = 20 days
ElseIf Surplus	> 30,000 ac-ft	Peak Flow = 4,000 cfs; Recession Length = 20 days
ElseIf Surplus	> 5,000 ac-ft	Peak Flow = 1,000 cfs; Recession Length = 6 days
Else		No pulse release

- The pulse releases are made starting at 1,000 cfs and increasing by 1,000 cfs per day until the peak is reached.
- The peak release is maintained for as many days as possible according to the available surplus allowing for the volume required for the recession, (always releasing at least 1,000 cfs for at least seven days).
- The recession releases decrease from 500 cfs to 45 cfs over the recession length.

After pulse release make releases as follows. If storage is greater than the target storage for a given month, releases are made to try to meet the target storage by the end of the month.

Storage Condition	Criteria	Release (Subject to Release Capacity)
If Storage	> Target Storage	Maximum of: Good Release, or Storage Deviation * (Current Day / 31)
ElseIf Storage	>= 80,411 ac-ft (1,100 ft)	Good Release
Else		Low Release

Where:

Storage Deviation = Current Storage - Target Storage
and

Month	Target Storage (acre-feet)	Good Release (cfs)	Low Release (cfs)
Apr	109,611	40	10
May	104,611	50	10
Jun	99,211	50	10
Jul	93,811	50	10
Aug	88,411	50	10
Sep	83,911	50	10
Oct	80,411	40	10

Appendix F

Eagle Nest Protection Rule

The following rule is used between November 1 and July 31 if an eagle nest is vulnerable (at least one active nest over the reservoir). The rule can be written as:

Storage Condition	Criteria	Release (Subject to Release Capacity)
If Storage Deviation	≥ 0	Maximum of: Good Release, $0.95 * \text{Net Inflow}$, or $0.90 * (\text{Net Inflow} + \text{Storage Deviation})$
ElseIf Storage Deviation	$\geq 80,411 - \text{Storage Target}$ <i>(Storage between Storage Target and 1,100 ft elevation)</i>	Maximum of: Good Release, or $0.90 * (\text{Net Inflow} + \text{Storage Deviation})$
ElseIf Storage Deviation	$\geq 24,372 - \text{Storage Target}$ <i>(Storage between 1,100 ft and 1,070 ft elevation)</i>	Maximum of: Low Release, or $0.50 * (\text{Net Inflow} + \text{Storage Deviation})$
Else	<i>(Below 1,070 ft)</i>	Maximum of: 0 cfs, or $0.50 * (\text{Net Inflow} + \text{Storage Deviation})$

Where:

Storage Deviation = Current Storage - Target Storage

Net Inflow = Inflow - Evaporation

Target Storage = 101,000 (1,107.3 feet elevation)

Month	Good Release (cfs)	Mid Release (cfs)	Low Release (cfs)
Jan	25	10	10
Feb	40	25	10
Mar	40	25	10
Apr	40	25	10
May	50	25	10
Jun	50	25	10
Jul	50	25	10
Aug	50	25	10
Sep	50	25	10
Oct	40	15	10
Nov	25	10	10
Dec	25	10	10

Pulse Flows are sustained by:

```
IF Release > 1,000 cfs THEN
  IF Month > 0 and < 6
    Maintain Release >= 1,000 cfs for at least 7 days
  ENDIF
ENDIF
```